# Exploring Sugar Sweetened Beverage Consumption and Body Composition among Appalachian Teens

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**Abstract**

A factor gaining increased attention in research and clinical practice regarding adolescent obesity prevalence is sugar sweetened beverage (SSB) consumption and its role in health outcomes. Adolescents residing in rural Appalachia have the highest consumption rate of SSBs when compared to other adolescent populations. The purpose of this study was to explore SSB consumption patterns among adolescents residing in rural Appalachia. Obesity-related health outcomes – body mass index (BMI) and body fat percentage – and their relationship to SSBs were also examined. This cross-sectional study was a secondary data analysis of a sub-sample of high school aged participants enrolled in a larger randomized controlled trial. For this study, Wave 1 and Wave 2 baseline data from subjects at 11 schools was analyzed ($n = 361$). Descriptive and inferential statistics were conducted. Bivariate Pearson correlations, Spearman correlations and independent t-tests were conducted with a $p = .05$. Over one-third of subjects were classified as either overweight (22.5%) or obese (20.8%). Nearly five percent were classified as morbidly obese with a BMI over 40. Girls had a higher body fat percentage (32.8%) when compared to boys (21.3%), indicating a gender difference ($t = 12.1$, $df = 331$, $p = .000$). More than half of the subjects reported consuming SSBs at least four days per week, with 30% consuming SSBs seven days per week. The mean SSB servings per day was 2.8 ($SD = 2.76$). BMI was related to the number of SSB servings per day ($r = .11$, $p = .05$), while body fat percentage was related to the number of days per week that SSBs were consumed ($r = .10$, $p = .05$). Although this study was exploratory in nature, promoting a reduction of SSB consumption may improve obesity related health outcomes in a population that still suffers from pervasive obesity.

Obesity is a pervasive public health problem in the United States, especially for the adolescent population. Obesity rates have tripled within the last three decades in the child and adolescent population. To date, about one third of adults and 17% of adolescents are obese, with a total of 31% of children being either overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014). Obesity in children and adolescents is defined as at or above the $95^{th}$ percentile of body mass index (BMI) measurements for age and gender (Ogden, Carroll, Kit, & Flegal, 2014).

Several factors are related to the increasing obesity trend in American society. A major contributor to obesity in adolescents that is gaining increased attention is sugar sweetened beverages (SSBs). As the intake of sugar sweetened beverages has rapidly increased, the prevalence of obesity in the American population nearly tripled (Kavey, 2010). It is estimated that sugar sweetened beverages may be responsible for at least one fifth of weight gained in the U.S. over a period of three decades (Woodward-Lopez, Kao, & Ritchie, 2011). Although childhood and adolescent obesity levels have plateaued nationally, obesity and overweight prevalence within this population have increased within rural areas, especially the Appalachia region (Appalachian Regional Commission, 2014). It is suspected that sugar-sweetened beverage consumption and obesity rates are closely correlated in Appalachia, due to environmental and social influences (Appalachian Regional Commission, 2014). To date, the consumption patterns of SSB and the relationship to health outcomes are not well understood, especially with teens residing in Appalachia.

The purpose of this study was to explore the relationship between sugar sweetened beverage (SSB) consumption among adolescents in Appalachia and health outcomes: body mass index (BMI) and body fat percentage. This study targets the population of teens that have the highest SSB consumption rates, and measures health outcomes beyond just BMI. Adolescents within the Appalachian population have had minimal involvement in past research. In addition, many studies rely on self-reported body composition to determine BMI. This study provides important information on an understudied population by measuring fat percentage in addition to BMI, and collecting measures via a body composition analyzer rather than self-report.

This research was shaped by the socioecological model, which emphasizes the importance of geographic location in relation to health behaviors and outcomes. Exo-system is defined as the Appalachian region and local community. The mesosystem is the school each participant attends. Microsystem is defined as the peers, family, and friends that influence health behaviors. Research has shown that the obesity epidemic has a more profound impact in certain geographic regions in the U.S. (Montgomery-Reagan, Bianco, Heh, Huston, 2009). In rural areas such as Appalachia, factors such as poverty and health disparities influence and increase the occurrence of obesity (Montgomery-Reagan, Bianco, Heh, Huston, 2009). Teens residing in rural Appalachia consume SSBs at much higher rates compared to teens in other geographic areas. SSB consumption in this region is likely correlated with geographical disparities.

The research questions were:

(1) In high school aged Appalachian adolescents, is SSB consumption measured in days per week related to Body Mass Index?

(2) In high school aged Appalachian adolescents, is SSB consumption measured in days per week related to body fat percentage?

(3) In high school aged Appalachian adolescents, is SSB consumption measured in servings per day related to Body Mass Index?

(4) In high school aged Appalachian adolescents, is SSB consumption measured in servings per day related to body fat percentage?

(5) Are there differences in SSB consumption patterns based on gender?

(6) Are there differences in BMI based on gender?

(7) Are there differences in body fat percentage based on gender?

Limitations of this study include that survey data was self-reported by the participant. Self-reported survey data may be over or under reported due to participants anticipating the researchers' desired response. Another limitation is the study was cross-sectional, and the data was collected only at one point in time. An additional limitation is the measurements were obtained using bioelectrical impedance analysis (BIA). BIA is not the most perfect measurement; the most accurate measure to obtain body composition would be to use a body pod to submerge the participant. However, this is a community based study, and the Tanita DC-430U body composition analyzer used is a transportable device. The device is also FDA certified for research and clinical use.

## Literature Review

Articles were found in two main peer-reviewed databases: PubMed and CINAHL. Additional supplementary articles were found using the initial identified literature. Key search terms included: (a) sugar-sweetened beverage, (b) high school students, (c) adolescents, (d) Appalachia, (e) rural, (f) Ohio, (g) weight, (h) body mass index or BMI, and (i) body fat percentage. Also included were synonyms of these words. Advanced search and the AND/OR functions were also used. Inclusion criteria were hat the research was in English only, published in the US, and published within 10 years of the initial search year (2015). The following review of literature discusses the role of sugar sweetened beverages in the obesity epidemic nationally, within rural America and within Appalachia. Obesity within the Appalachian region and methods of weight measurement in research follow.

**Sugar Sweetened Beverages**

In the United States (U.S.), the principal source of added dietary sugar is sugar-sweetened beverage (SSBs), with many children and adolescents as regular consumers (Centers for Disease Control and Prevention (CDC), 2011a). Approximately 80% of children and adolescents drink at least one SSB daily. Adolescents ages 12-19 consume the most SSBs; it is estimated that 13% to 28% of their daily calories come from sugary beverages (Centers for Disease Control and Prevention (CDC), 2010). In a seven day recall survey, 62.8% of high school students drank sugar sweetened beverages or a combination of them on a daily basis, and 32.9% drank these beverages two or more times daily (Han & Powell 2013). In a secondary analysis of a 24 hour dietary recall from NHANES from 1999-2008, soda was reported as the most frequently consumed sugar sweetened beverage among adolescents ages 12-19 (Han & Powell, 2013). More than fifteen percent of high school students drank soda two or more times a day (CDC, 2011a). The literature has also shown overweight adolescents have a higher contribution to their daily caloric energy from soda, an SSB (Bermundez & Gao, 2010).

The relationship between SSB and health outcomes, especially in the adolescent population is beginning to be explored. Sugar sweetened beverages have a high glycemic index. The excess caloric energy SSBs provide has been found to be related to weight gain and increasing obesity rates (Kavey, 2010). Although few studies state that the association between sugar sweetened beverages and BMI is nonexistent (Forshee, Anderson, & Storey, 2008), increased weight and abdominal fat are consistently found to be related to sugar sweetened beverage consumption (Kavey, 2010; Woodward-Lopez, Kao, & Ritchie, 2011; Bermundez & Gao, 2010).

Bermundez and Gao found that those who drink 6 servings of SSBs daily are twice as likely to have increased abdominal adiposity and obesity (2010). Adolescents were at a 52% increased risk for obesity when 10 extra teaspoons of sugar were added per day through SSBs (Bermundez & Gao, 2010). This risk of obesity may be especially profound in adolescents, due to excess energy not being compensated for via physical activity (Harrington, 2008).

The literature has consistently supported that sugar sweetened beverages contributes to the obesity epidemic in the U.S. In a review of NHANES data from 1999-2000, persons who consumed high levels of SSBs had a larger BMI, waist circumference, and overall weight as compared to those with less SSB intake, even when individuals were similar in other factors such as height, age, physical activity, smoking, and educational level (Bermundez & Gao, 2010). Specifically in young adults and children, declines in SSB consumption led to weight loss and obesity declines (Sichieri et al., 2009). Further, in an intervention study involving fourth graders, there was a larger BMI reduction associated with decreased SSB intake, especially for children who were female or overweight at the study’s baseline collection (Sichieri et al., 2009). Additional evidence from two randomized studies suggest even small declines in SSB consumption can lower BMI values and obesity risks, especially in those who are already overweight or obese (Harrington, 2008).

Excess weight and SSBs have a dangerous relationship, which can be especially profound in children and adolescents. Although much research has been done nationally to highlight the concerning trend of increased adolescent SSB consumption, scant data is available for specific populations, especially Appalachians, with unique risk factors for obesity

## SSBs in Rural America

Adolescents residing in rural regions have significantly high rates of SSB consumption (Sharkey, Johnson, & Dean, 2011). Rural adolescents are more likely to consume larger amounts of SSBs than their urban counterparts. One study found that over 52% of rural residents consume at least one or more cans/glasses of SSB per day, as compared to only 43.7% of urban residents (Sharkey, Johnson, & Dean, 2011). Rural residents were also more likely to consume three or more cans/glasses per day than urban residents (Sharkey, Johnson, & Dean, 2011).

Individuals with a low socioeconomic status are more likely to consume a larger amount of SSBs, regardless of age (Han & Powell, 2013). Many families in rural areas also have a low socioeconomic status, which may affect their SSB consumption (Appalachian Regional Commission, 2014). A study conducted using data from American Chamber of Commerce Researchers Association (ACCRA) examined prices of different foods from 1990 to 2007. The price of soft drinks, a main SSB, had been reduced anywhere from 12%-32%, depending on the area while accounting for inflation, whereas foods such as fruits, vegetables, and dairy had not experienced these same price drops (Powell, Han, & Chaloupka 2010). The price reduction over time makes SSBs less expensive to purchase and consume when compared to healthier options to drink, such as milk. The impact of these price reductions were significant for adolescents of low socioeconomic status, and directly affected their BMI (Powell, Han, & Chaloupka, 2010).

Low socioeconomic status is profound in the Appalachian region. In response, the Appalachian population has some of the highest rates of SSB consumption nationwide (Smith, 2011). Appalachian children and adolescents have higher rates of consumption when compared to peers of the same age (University of Wisconsin Population Health Institute, 2014). Furthermore, compared to other regions, the Appalachian population has worse health and fewer beneficial health-related behaviors (Moore, Brinkley, Crawford, Evenson, & Brownson, 2013; Swanson, Schoenberg, Erwin, & Davis, 2013; Kruger et al., 2012). Appalachian youth have more limited nutritional knowledge than they may perceive, and food decisions were influenced by their environment, such as one's household, the lack of accessible food stores, and cost of healthy foods (Swanson, Schoenberg, Davis, Wright, & Dollarhide, 2013). These environmental factors impact the growing SSB consumption in Appalachia, but few research studies have been conducted in this region to examine SSB consumption among adolescents.

**Obesity in Appalachia**

The relationship between SSB consumption and excess weight and obesity is stronger than the connection between weight and any other food or beverage (Woodward-Lopez, Kao, & Ritchie, 2011). The increasing rates of SSB beverage consumption in Appalachia have contributed to the escalating obesity epidemic in this region (Woodward-Lopez, Kao, & Ritchie, 2011). Although the Appalachian region is diverse in culture, it is physically and statistically a "region apart" (Appalachian Regional Commission, 2014; Marcum, 2008). Education, employment, housing, poverty, access to care, socioeconomic status, quality of life, and other health indicators statistically trail behind the rest of the United States in this region (Smith & Holloman, 2011; CDC 2011b; Appalachian Regional Commission, 2014; Marcum, 2008). Some regions are more intensely impacted by the obesity epidemic in the U.S., especially in rural regions such as Appalachia where socioeconomic and health inequalities thrive (Montgomery-Reagan, Bianco, Heh, Rettos, & Huston, 2009). Compared to other regions, the Appalachian population is the most sedentary group in the U.S. (American Academy of Pediatrics, 2006; CDC, 2011b). Children in this population are 25% more likely to be obese or overweight (Lutfiyya, Lipsky, Wisdom-Behounek, & Inpanbutr-Martinkus, 2007). The disproportionate obesity rates within the Appalachian region suggest children have a higher likelihood of developing obesity depending on location (Patterson, Moore, Probst, & Shinogle, 2004).

Not surprisingly, one of the most prevalent health concerns among teens the Appalachian region is early-onset obesity. One can argue that obesity within Appalachia is related directly to SSB intake. The obesity rate within the Appalachian adolescent population is greater than 25%, surpassing the national averages for other adolescent populations (Bolin & Bellamy, 2011; Montgomery-Reagan, Bianco, Heh, Rettos, & Huston, 2009). These obesity rates are related to increased risk of morbidity and mortality due to co-morbid conditions such as diabetes, hypertension and other conditions related to obesity within the population (Ickes & Slagle, 2013).

When approximately 2,000 Appalachian children aged 6-11 participated in a school based BMI screening, 38% had an elevated body mass index (BMI), and 20.9% were overweight or obese (Montgomery-Reagan, Bianco, Heh, Rettos, & Huston, 2009). In another study of rural ninth grade students, findings suggested that normative obesity in the region affected adolescents' perceptions of normal weight (Williams, Taylor, Wolf, Lawson, & Crespo, 2008). Obesity and SSB consumption has significantly increased in the Appalachian region, yet few studies have examined the relationship between obesity and sugar sweetened consumption in rural Appalachia.

## Measuring Obesity

In most studies, Body Mass Index (BMI) percentile is calculated for age and gender to measure obesity. An individual's BMI is obtained by dividing the individual's weight (kilograms) by his/her height (meters) squared (CDC, 2015). A child or teenager with a BMI between the $5^{th}$ and $85^{th}$ percentile would be considered at a healthy weight (CDC, 2015). An overweight child or teen would have a BMI between the 85$^{th}$ and 95$^{th}$ percentile (CDC, 2015). A child or teen that is obese would have a BMI at or above the 95$^{th}$ percentile (CDC, 2015). The World Health Organization has also defined the same BMI ranges for determining overweight and obese (Stevens, McClain, & Truesdale, 2008).

BMI, especially self-reported, may be the easiest way to calculate obesity, but is not the most reliable and/or accurate (Stevens, McClain, & Truesdale, 2008; Stommel & Schoenborn, 2009). BMI is not effectively able to differentiate between muscle and fat tissue. Likewise, it cannot assess the distribution of body fat (Stevens, McClain, & Truesdale, 2008). In the growing adolescent population, these seemingly minor factors could be essential in determining current and future health. In a study that followed subjects over a 25 year interval, results suggested that with no change in BMI, waist circumference still increased in all four races, suggesting the relationship of fat and muscle mass had changed (Stevens, McClain, & Truesdale, 2008). In addition to errors within BMI, self-reported BMIs also increase the risk for error.

In an NHANES data analysis from 2001 to 2006, self-reported height and weight versus physical examination findings were compared. These data was then used to determine individual BMI. Findings suggested classification errors error more frequently in those who are over- or underweight. Nineteen percent of individuals whose self-reported BMI data self-classified as overweight but were actually obese according to physical exam data (Stommel & Schoenborn, 2009). These findings are especially significant for women, who already have an increased level of adipose tissue when compared to men (Stevens, McClain, & Truesdale, 2008), and tend to underreport weight (Stommel & Schoenborn, 2009). Other obesity measures such bioelectrical impedance analysis to determine fat mass and percent body mass have not been extensively studied, but provide a more complete analysis of the individual's adipose tissue and body composition. Literature linking obesity and SSBs has extensively relied on BMI, especially self-reported measures. Few studies examine other potentially more accurate measures of obesity such as fat mass and fat percentage.

## Conclusion

The literature supports a direct and negative relationship between sugar sweetened beverage consumption and obesity rates nationwide with the effect of SSBs being especially profound within the child and adolescent population (Kavey, 2010; Woodward-Lopez, Kao, & Ritchie, 2011; Bermundez & Gao, 2010; Harrington 2008). In addition, SSB consumption is disproportionally increased within the Appalachia region (University of Wisconsin Population Health Institute, 2014). Data strongly suggests that Appalachian teens are at increased risk of weight gain and obesity due to SSB consumption yet little data exists for this population. In addition, most data utilizes BMI as the primary measure of obesity. Body Mass Index is often not the most accurate measurement, especially for the adolescent population (Stevens, McClain, & Truesdale, 2008; Stommel & Schoenborn, 2009). In order to further examine the relationship between SSBs and obesity within the adolescent Appalachian population, an analysis using more precise measurement of body composition that include mass and fat percentage should be considered.

## Methods

This study was a secondary data analysis of cross-sectional sample of high school students participating in a larger randomized control trial, "*Planning to Be Active"* (PBA), in rural Appalachian Ohio. *Planning to Be Active* is a group randomized control trial (RCT) study that implements behavioral interventions taught by either a peer mentor or classroom teacher. The program evaluates the effectiveness of these two delivery methods for the intervention on adolescent physical activity (sedentary, light, moderate, and vigorous) and health outcomes (body mass index, body fat percentage, and body fat mass).

The sample for this secondary analysis consists of Wave 1 and Wave 2 baseline data from 361 subjects at 11 rural Appalachian schools in Ohio. At the classroom delivery schools, all high school participants that were registered in the health or physical education courses in which the intervention was offered were eligible to participate. All 9th or 10th graders who were not engaged in sports were eligible to participate in the mentoring schools. Eleventh or 12th graders were recruited to be trained as peer mentors at the mentoring schools. Peer mentors could not have a BMI above 24.9. All participants had to understand spoken English, able to participate in physical activity, and planned to remain in the participating school until the completion of data collection.

As a part of the data collection team, data was gathered at three separate points throughout the RCT study – pre-intervention (baseline), three months post-intervention, and six months post-intervention (beginning of next school year). The participants were given a $15.00 incentive at each data collection time point. This secondary analysis includes only on the data collected at the pre-intervention (baseline) stage for Wave 1 and Wave 2 schools.

Baseline data for physical health measures was collected using a body composition analyzer, the Tanita DC-430U. The Tanita DC-430U is portable, clinically shown to provide valid and reliable results, and certified for use in research settings. Per standard protocol, the Tanita DC-430U requires entry of the subject’s identification number, age, gender, and height. Height was not self-reported; it was measured using a portable stadiometer and recorded as feet and inches (to the nearest 1/8th inch) during data collection process. The participants were asked to remove their socks, remove unnecessary clothing or items, and stand upright on the analyzer for 30 seconds. The analyzer provided a printout for each participant that was stapled to the survey form.

The CDC definitions of BMI and childhood obesity were used as standard parameters for participants. Body fat percentage is defined by the Tanita DC-430U as "the amount of body fat as a proportion of your body weight" (Tanita Corporation, 2016, page 20). For high school females, a healthy body fat percentage is 16-29%; for high school males, a healthy body fat percentage is 10-20% (Tanita Corporation, 2016, page 20).

Baseline data for health outcomes, health behaviors, and SSB consumption was collected using the completion of surveys. Demographic information was also collected via survey at baseline. In this study, sugar sweetened beverages were defined as" pop, sweet tea, flavored coffee drinks, sports drinks, and fruit juice".

Descriptive and inferential statistics were conducted for independent and dependent variables using IBM SPSS statistical software. Bivariate Pearson correlations, Spearman correlations, and independent t-tests were conducted with significance of $p = 0.05$. This study expected positive relationships between the consumption of SSBs, BMI, and body fat percentage.

## Results

This study was conducted during the 2015-2016 and 2016-2017 school years. A total of 361 students at 11 high schools participated in baseline data collection. The adolescent sample is reflective of the Appalachian region with 90% of the participants classifying as "White/not of Hispanic origin". This racial profile mirrors the Appalachian region, which is predominantly White or Caucasian. The majority of participants were female (51.8%), and in the 9$^{th}$ (n = 167) or 10$^{th}$ grade (n=96). Participation by 11$^{th}$ and 12$^{th}$ graders was limited, due to high frequency of involvement in vocational programs outside of the high school setting. Participation among 12th graders was also limited due participation being dependent on being chosen as peer mentors. The project did not recruit 12th graders to serve as peer mentors for Wave 2 of the study. The students' ages ranged from 14-18 year of age, and the mean age was 15.2 years of age. Table A1 contains additional demographic information.

**BMI, Body Fat Percentage, and SSB Consumption**

Participants' BMI ranged from 16.5 to 58.6. Over forty percent of the participants classified by BMI as either overweight (22.2%) or obese (20.8%). Nearly 5% of participants classified as morbidity obese, with a BMI over 40. Participants' body fat percentage ranged from 5.5% to 56.8%. Nearly 40% of participants had a body fat percentage over 29%, which is classified as overweight for both males and females (Tanita Corporation, 2016, page 20). Over 25% had a body fat percentage over 34%, which is classified as obese for both males and females (Tanita Corporation, 2016, page 20). More than half of the participants reported consuming SSBs at least 4 days per week. Nearly 1/3 of participants (30%) reported consuming SSBs 7 days per week. The subjects' mean SSB was 2.8 servings per day.

The results of the research questions are as follows:

**In high school aged Appalachian adolescents, is SSB consumption measured in days per week related to Body Mass Index?**

The number of days per week SSBs were consumed was not related to BMI ($r = .06$, $p = .05$).

**In high school aged Appalachian adolescents, is SSB consumption measured in days per week related to body fat percentage?**

Days per week SSBs were consumed was significant and related to body fat percentage ($r = .10$, $p = .05$).

**In high school aged Appalachian adolescents, is SSB consumption measured in servings per day related to Body Mass Index?**

SSB servings per day was significant and related to BMI ($r = .11$, $p = .05$).

**In high school aged Appalachian adolescents, is SSB consumption measured in servings per day related to body fat percentage?**

SSB servings per day was not significant when compared to body fat percentage ($r = .04$, $p = .05$).

**Are there differences in SSB consumption patterns based on gender?**

The data collected showed consumption patterns were similar across genders. Male participants' mean SSB consumption days per week was 3.85 ($SD = 2.37$), while female participants' mean SSB consumption days per week was 4.20 ($SD = 2.45$). Male participants' mean SSB servings per day was 3.13 ($SD = 2.94$), while female participants' mean SSB servings per day was 2.60 ($SD = 2.60$). The differences were not statistically significant.

**Are there differences in BMI based on gender?**

The data showed no differences in BMI based on gender. The mean BMI for both male and female participants was 25.8, which is classified as overweight (CDC, 2015).

**Are there differences in body fat percentage based on gender?**

There were differences in body fat percentage based on gender. The mean male body fat percentage was 21.3%, and the mean female body fat percentage was 32.8% ($t = 12.1$, $df = 331$, $p = .000$). This difference is reflective of the difference in male and female fat accumulation, and is consistent with specific gender standards. The mean body fat percentage for both male and female participants is classified as overweight for both genders (Tanita Corporation, 2016, page 20).

## Discussion

The results indicated that SSB consumption is positively related to BMI and body fat percentage in Appalachian teens. Due to the socio-demographic homogeneity of the region and participating schools, these results are likely reflective of the larger Appalachia region. According to the data collected, SSBs are a significant source of sugar and calories in the diet for over 30% of the teens in this region. SSB consumption and excess weight and obesity have a stronger positive relationship than any other food or beverage (Woodward-Lopez, Kao, & Ritchie, 2011).The additional calories and sugar contained in SSBs consumed daily by Appalachian teens have the potential to add not only extra weight, but also pose additional health concerns to an already at-risk population. For example, it has been found that when 10 extra teaspoons of sugar are added to the daily diet by SSB consumption, adolescents were at a 52% increased risk for obesity (Bermundez & Gao, 2010). In this study, the mean number of servings per day of SSBs was 2.8 servings per day which would add over 100 grams of extra sugar daily to their diet greatly increasing the risk of obesity and other co-morbid conditions. The Appalachian region already has unique socioeconomic, familial, and cultural risk factors contributing to excess weight among this population. The consumption of SSB among adolescents exacerbates the obesity epidemic in this region.

Morbid obesity is a major health concern revealed within in the adolescent population in Appalachia. In our study, nearly 5% of the teens were classified as morbidly obese. Morbid obesity has an uncertain impact on adolescent's long-term health outcomes, but the risks of reduced life span and co-morbidities are greatly increased (Kitahara et al., 2014). A BMI over

40kg/m2 is estimated to reduce life expectancy by 6.5 to 13.7 years in adults (Kitahara et al., 2014). For children and adolescents with a BMI over 40kg/m2 the life expectancy is unknown, but even further estimated loss of years of life and quality of life is expected. Co-morbidities such as heart disease, diabetes mellitus type II, and certain cancers increase as BMI and body weight increases (CDC, 2015; Kitahara et al., 2014). Illness and early death from earlier acquisition of these serious comorbidities is a serious concern in the Appalachian region.

Although morbid obesity is a serious health concern in this adolescent population, the results suggest that underweight and malnutrition are also health concerns in this region. Nearly 7% of the sample had a BMI under 18.5, which is considered underweight by the CDC (2015). Similar to obesity, underweight and malnutrition leads to serious effects on adolescents' long term health outcomes. For example, malnutrition can result in growth and cognitive impairment (CDC, 2015). Since underweight and malnutrition was not the focus on the current study, further research is needed to examine this health concern in the Appalachian region, where the focus has primarily targeted obesity and its co-morbidities.

The Appalachian region is often defined as "a region apart" (Appalachian Regional Commission, 2014). This study supports those adolescents residing in this region report increased rates of SSB consumption and obesity compared to adolescents nationally. Due to the unique geographic, socioeconomic, cultural, and health factors in this region, specialized and personalized health interventions are required to reduce SSB consumption and improve health outcomes in this region. Further research should support community and peer based interventions to empower community residents to change health behaviors and "move the needle" on obesity in this region. Although this study was exploratory in nature, promoting a reduction of SSB consumption may be one small step to ultimately improve obesity related health outcomes in a population that still suffers from pervasive obesity.

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## Appendix A

Table A1: Demographic Data

| | | |
|---|---|---|
| **Gender** | Total n | 334, missing 27 |
| | Male/Boy | 161 (48.2%) |
| | Female/Girl | 173 (51.8%) |
| **Grade** | Total n | 332, missing 29 |
| | $9^{th}$ | 167 (50.3%) |
| | $10^{th}$ | 96 (28.9%) |
| | $11^{th}$ | 58 (17.5%) |
| | $12^{th}$ | 11 (3.3%) |
| **Race/Ethnicity** | Total n | 327, missing 34 |
| | White, not of Hispanic origin | 291 (89%) |
| | Black, not of Hispanic origin | 15 (4.6%) |
| | Hispanic or Latino | 3 (0.9%) |
| | American Indian/Native American | 30 (9.2%) |
| | Asian/Pacific Islander | 2 (0.6%) |